CAMPO
NC Capital Area Metropolitan Planning Organization

GO FORWARD
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CAMPO BRT Extension MIS

Evaluation of Alternatives Report

January 2022

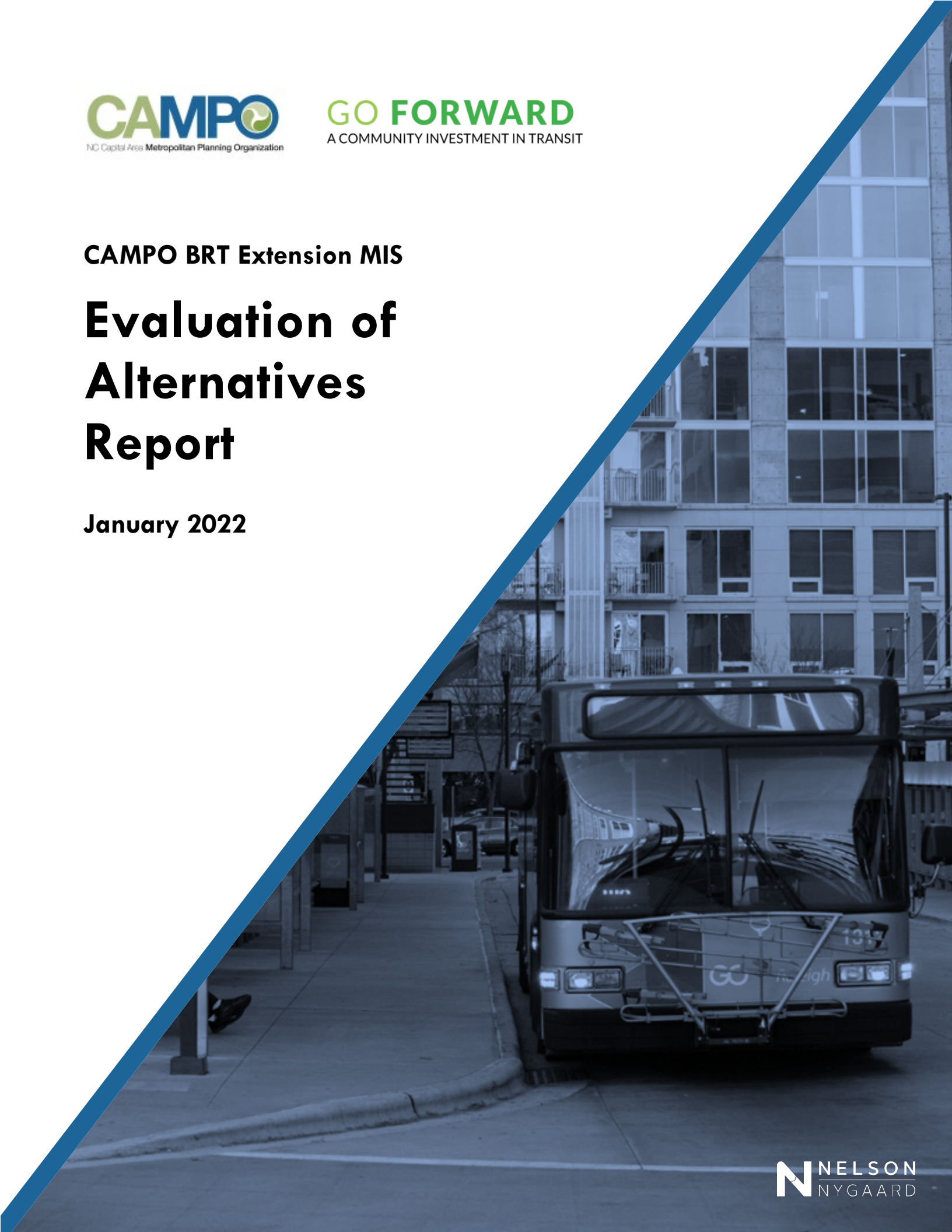

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Table of Contents

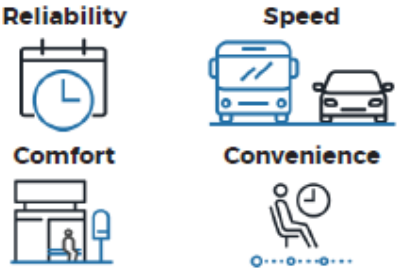
Tables and Figures

1 INTRODUCTION

The Wake BRT Rapid Bus Extension Study's Alternatives Analysis (AA) identifies, evaluates, and recommends potential rapid bus extension alternatives for two corridors in the Wake Transit Plan Bus Rapid Transit program. The rapid bus service would connect Cary to Research Triangle Park (RTP) in the Western rapid bus extension (Western Extension) and the Towns of Garner to Clayton in the Southern rapid bus extension (Southern Extension).

These rapid bus connections would be extensions of the planned Western Corridor BRT, connecting downtown Raleigh with Cary, and the planned Southern Corridor BRT that would connect Raleigh with Garner. Both corridors were identified in the Capital Area Metropolitan Planning Organization's (CAMPO) *2045 Metropolitan Transportation Plan* (MTP) and the *2020 – 2029 Transportation Improvement Program* (TIP) as a regional project connecting Clayton to RTP.

This study identified **four (4) key elements of BRT** that are fundamental to the rapid bus extensions:

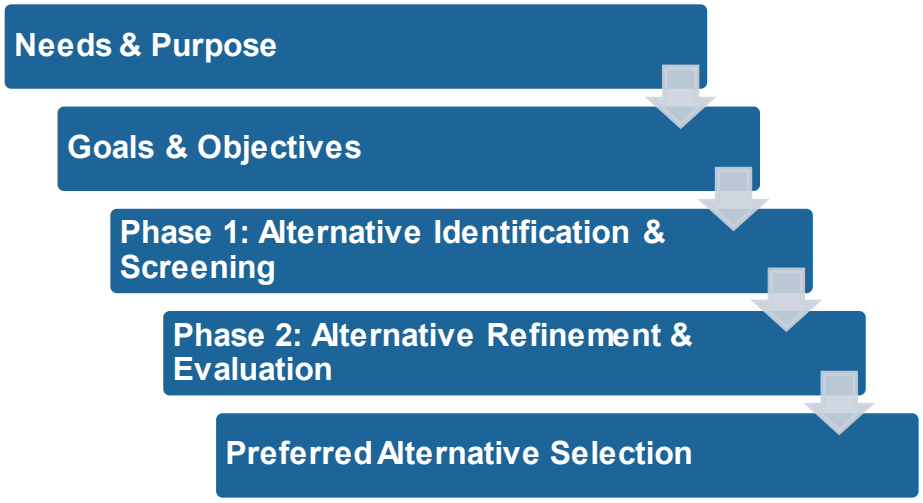


The study also identified **four (4) goals** for the proposed rapid bus service:

- **Provide access to local or regional destinations and major activity centers**
- **Create productive and sustainable service**
- **Align safety and compatibility with the surrounding environment**
- **Provide access to transit services**

The AA process will result in the selection of a Locally Preferred Alternative (LPA) that sets the stage for future investments in each of the extensions.

Figure 1 CAMPO Rapid Bus Extension Alternative Analysis Process



The AA process included two analysis phases. Both phases of the analysis aligned data-oriented criterion and metrics with the study's goals and objectives to inform decision making.

- **Phase 1 Screening** primarily utilized existing conditions and adopted plans/projects along individual roadway segments within the extensions to identify those with the highest potential to support rapid bus service. These segments were then combined into end-to-end alignments for further development and evaluation.
- Capital infrastructure and operating assumptions for each alignment were refined into final alternatives for **Phase 2 Evaluation** using detailed criteria. The comparative performance benefits and impacts of alternatives in the planning horizon were considered.

This document focuses on the process and results of the Alternative Refinement and Evaluation stage. Chapter 2 summarizes the findings from the Phase 1 screening and provides an overview of the process for Phase 2. Chapter 3 defines the final alternatives that are under consideration for each extension. Lastly, Chapter 4 details the evaluation results for Phase 2 evaluation.

2 ALTERNATIVES ANALYSIS PROCESS

For independent utility, rapid bus alternatives were comparatively evaluated as separate services from core Wake BRT. Recommendation of roadways most supportive of rapid bus service implementation only considered the performance of alternatives within the defined boundaries of this rapid bus extension study.

As population growth and land use changes within the region continue towards the 2050 planning horizon, rapid bus service is ultimately envisioned to operate as a seamless extension of the core Southern and Western BRT. The option of operating continuous BRT service from downtown Raleigh to RTP and Clayton was not precluded within this study. Components of this Operating Plan also consider the potential incremental capital and operating costs, as well as ridership impacts, of operating one-seat-ride service between Raleigh and Clayton and Raleigh and Garner.

PHASE 1 SCREENING

Multi-step Screening

The Phase 1 screening of the alternatives included a review of each potential roadway segment based on screening criteria and identified potential end-to-end alternative alignments for each extension.

The screening criteria used to evaluate each extension relied on data from the *Existing Conditions Report* and included both qualitative and quantitative measures including current roadway conditions, network opportunities, and socioeconomics. The first stage of analysis included 4 basic components:

a) **Corridor Segmentation** –Roadway segment and routing options throughout the extension, and potential travel markets they might serve.

b) **Context and Fatal Flaws** – determine the critical factors, considerations, and components for transit supportive conditions.

c) **Initial Screening** – qualitative assessment of potential roadway segments to guide development of potential end to end alignment options.

d) **Alternative Alignment Screening** – determines the end-to-end alignments that best support rapid bus operation from terminus-to-terminus.

The potential segmentation shown in Figure 2 illustrates the roadways considered between Garner and Clayton, while Figure 3 shows the roadways considered for potential routing of service between the Cary Depot and Hub at RTP.

Figure 2 Southern Rapid Bus Potential Segmentation

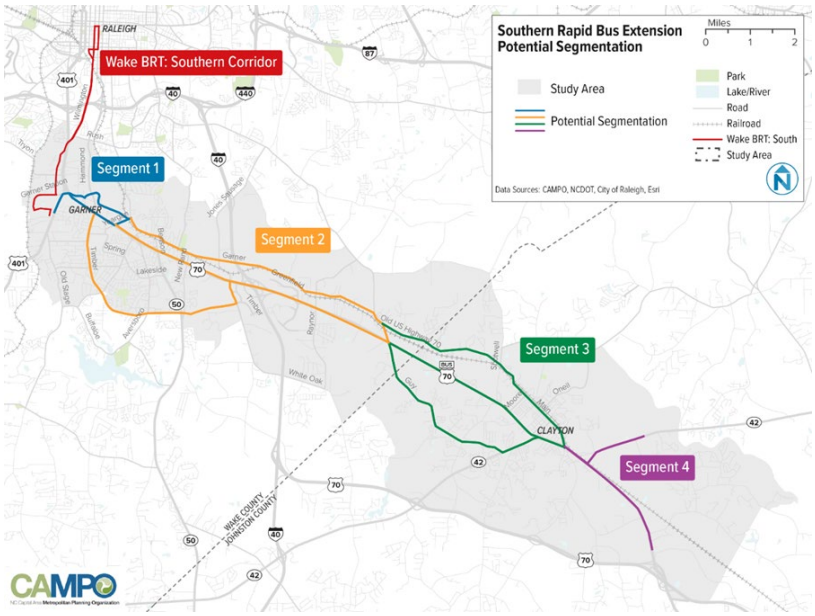
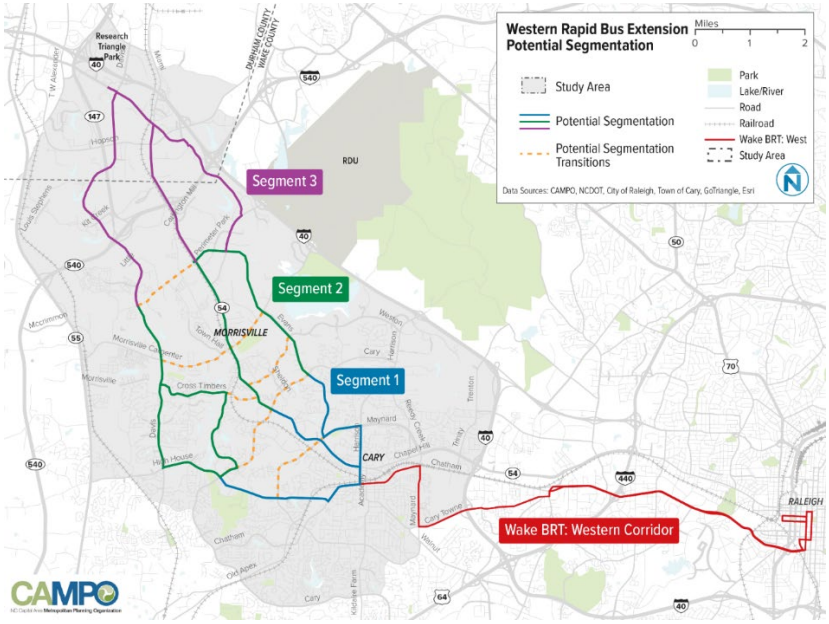


Figure 3 Western Rapid Bus Potential Segmentation



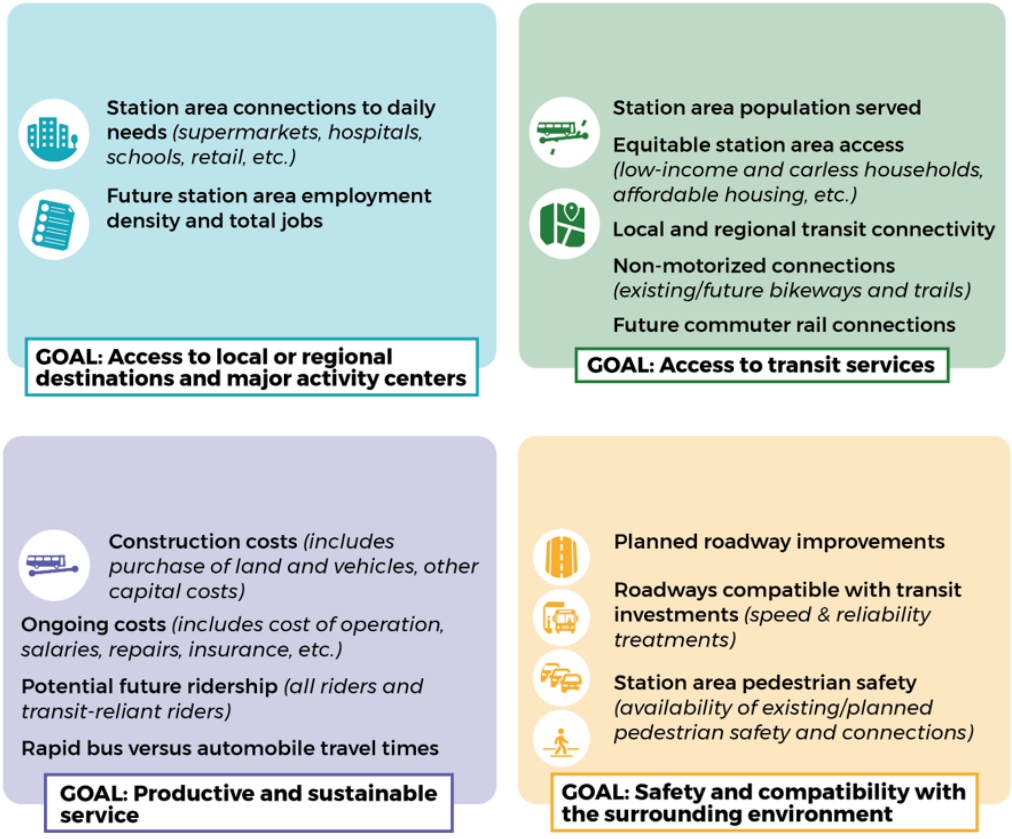
The Southern Extension Phase 1 screening results identified US 70/US 70 Business as the most appropriate route alignment between (approximately) Timber Drive and NC 42. The Phase 2 evaluation compared alternative alignments routing to terminal stations in Garner and Clayton (Figure 4). The Western Extension Phase 1 screening results identified three (3) three end-to-end alignments that could support rapid bus service from Cary to RTP (Figure 7).

Detailed results of initial screening are found in the *AA Framework and Phase 1 Screening Memo (October 2022).*

PHASE 2 EVALUATION CRITERIA

The second phase of the evaluation process continued the use of data-intensive methods to estimate and forecast the potential performance and tradeoffs of final end-to-end alternative alignments within each extension. Figure 4 below, shows the considerations included within the Phase 2 evaluation.

Figure 4 Phase 2 Evaluation Criteria Framework



3 DESCRIPTION OF FINAL ALTERNATIVES

Based on the results of the Phase 1 Screening and stakeholder feedback, the project team refined the potential alignment options into the final alternatives for each extension, discussed below.

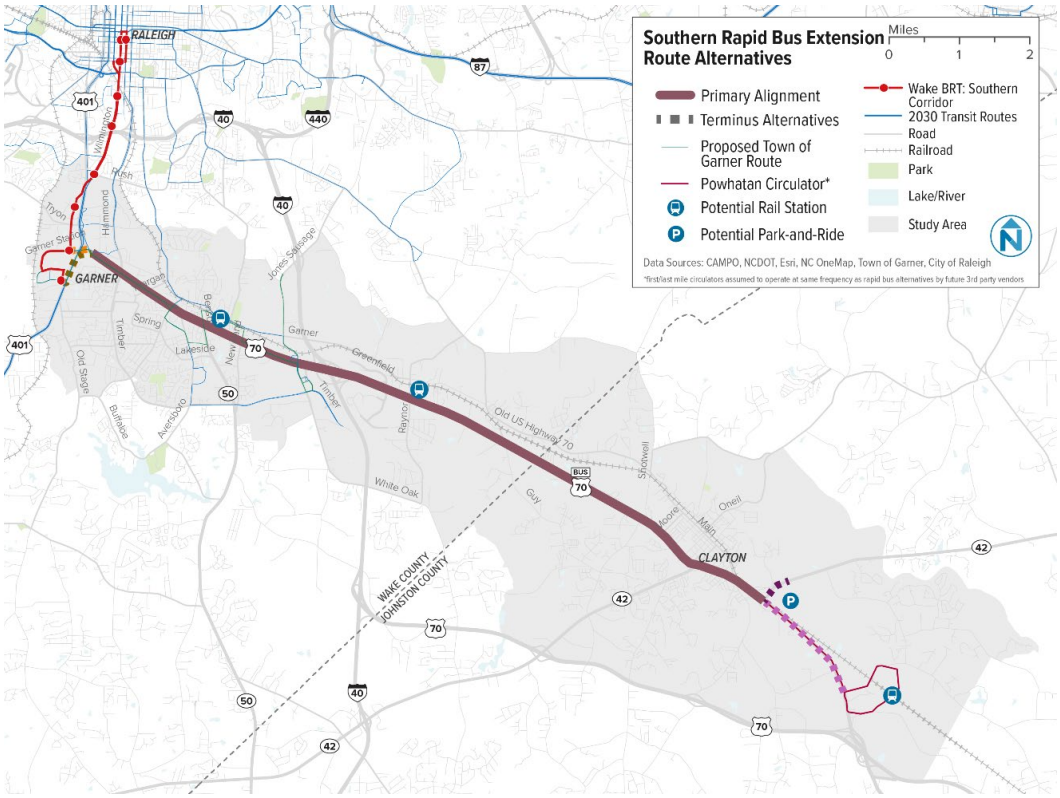
Southern Extension

Southern Alternatives Alignments

Final Southern Extension alternatives utilize US 70/US 70 Business for primary connections between Clayton and Garner Station, with two routing alternatives at terminal endpoints shown in Figure 5. The primary alignment also includes an option to deviate to a potential future Auburn CRT station.

To support the Clayton terminal option (C1) at the proposed park and ride at NC 42, a new third-party circulator is assumed to provide extended connections between the park and ride, East Clayton Industrial Area (ECIA), and (future) Powhatan CRT station.

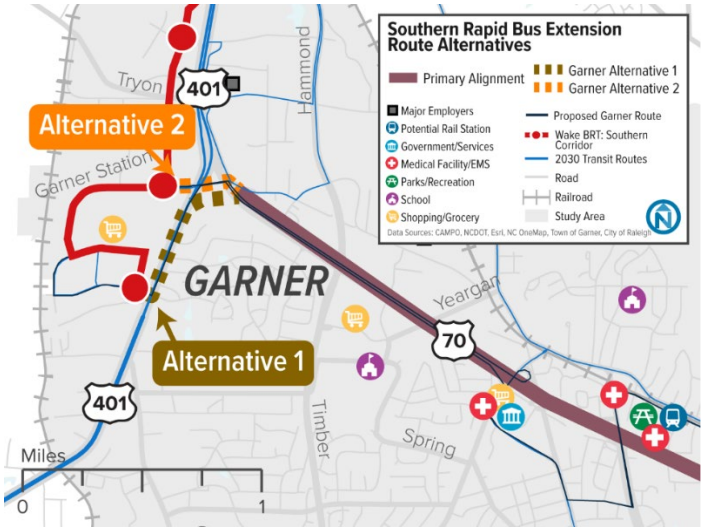
Figure 5 Southern Rapid Bus Extension Route Alternatives



The two alternative routing options evaluated in Garner Station were evaluated for rapid bus service connection with the future Southern BRT terminus, Walmart at US401/Fayetteville Road (Figure 6).

- **(G1) Garner Alternative 1:** Travels south from the US 70 and US 401 interchange along US 401/Fayetteville Rd to Purser Dr and Rupert Rd.
- **(G2) Garner Alternative 2:** Connects to the future Southern BRT station via Garner Station Blvd/Mechanical Blvd, maintaining an option to serve the BRT terminus as well.

Figure 6 Southern Rapid Bus Extension Garner Alternatives

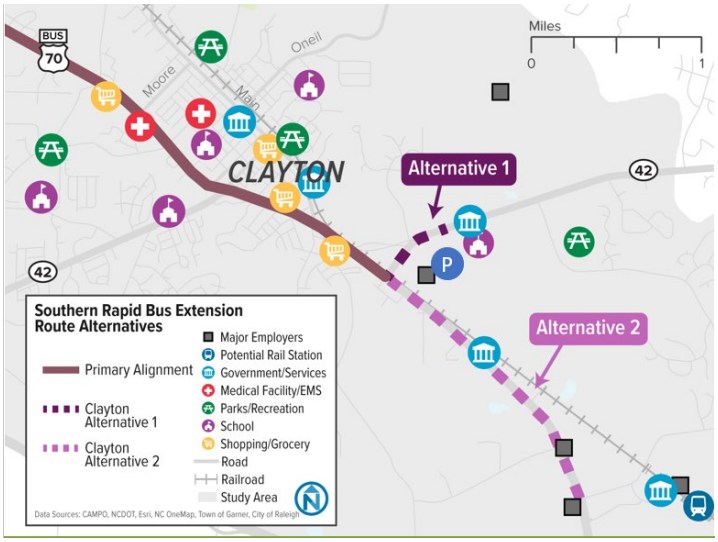


Near Clayton, two alternative termini were considered (Figure 7).

- **(C1) Clayton Alternative 1:** Connects to a potential future park and ride lot option at the NC 42 intersection and community college on NC 42.
- **(C2) Clayton Alternative 2:** Connects to a potential future park and ride at NC 42 and continues farther south to Powhatan Road serving the East Clayton Industrial Area (ECIA).

For both alternatives C1 and C2, the terminal station was assumed to be served by a third party first mile/last mile circulator service connecting the rapid bus to the potential commuter rail station and major employers in the ECIA.

Figure 7 Southern Rapid Bus Extension Clayton Alternatives



Southern Station Area Improvements

The southern extension would have approximately 10 to 12 stations, selected based on the presence of activity centers and development nodes, signalized intersections, and accessible pedestrian networks. The design of the stations would be based off Wake BRT: New Bern's peripheral station types, including components such as:

- 24 ft. branded shelters
- Platforms able to accommodate 40-ft or 60-ft buses
- Real-time information
- Lighting and wayfinding
- Fare payment and ticket vending
- Sidewalk connectivity and pedestrian crossing protection

Additionally, the project team identified the opportunity for joint development of a potential park-and-ride at the site of proposed development near US70 Business/NC42.

Southern Transit Priority Treatments

Transit priority treatments helping rapid bus services operate in a fast and reliable manner assumed transit signal priority (TSP), transit queue jump and bypass lanes, as well as spaces for transit only operations.

- TSP gives buses priority at intersections through adapting signal timings and would be implemented at all signalized intersections within the extension.
- Queue jump or bypass lanes are designated spaces that allow buses to proceed through a signalized intersection ahead of general traffic. TSP technology is also instrumental in initializing the bus-only phase to allow for early procession. These were assumed at signalized intersections where existing or planned roadway improvements support their deployment.

- Along the primary alignment of US 70 / US 70 Business, there could also be an opportunity to implement a Bus on Shoulder System (BOSS), where buses would be permitted to operate at low speed on the highway shoulder during congested conditions. These lanes would be most feasible and beneficial in segments of planned widening along US 70 Business between I-40 and Robertson Street in Clayton.

Refer to the *CAMPO Rapid Bus Operating Plan, Feasibility, and Operations Analysis (April 2023)* for further information.

Southern Operating Profile

The rapid bus extension is proposed for revenue service between 2030 and 2040, alongside an updated local bus network and commuter rail. Weekday rapid bus service is proposed to operate from 5AM to midnight, matching that of Wake BRT: Southern Corridor. The service would run every 30 minutes at peak and 60 minutes off peak. The Powhatan / ECIA circulator was assumed to operate at 30-minute headways all day while the rapid bus service is in operation, providing employee shuttle service to major employers such as Grifols and Novo Nordisk.

To remain compatible with maintenance and storage facility (MSF) requirements associated with Wake BRT and GoRaleigh preliminary engineering designs and specifications, rapid bus extensions assume deployment of 40-foot, CNG-fueled buses.

While the detailed evaluation compared the alternatives assuming independent utility (operating from Garner to Clayton), the project team's ridership modeling also analyzed the service as a one-seat ride into Raleigh. That analysis assumed compatible vehicles to serve limited stops at major connection points and activity centers along the core BRT segment.

Refer to the *CAMPO Rapid Bus Operating Plan, Feasibility, and Operations Analysis (April 2023)* for further information. This study assumed the development and operating costs of the proposed 3rd party circulator service are the responsibility of local, and potentially benefiting, employers and stakeholders. Circulator capital and recurring operating and maintenance (O&M) costs were not considered in the estimated costs of rapid bus alternatives.

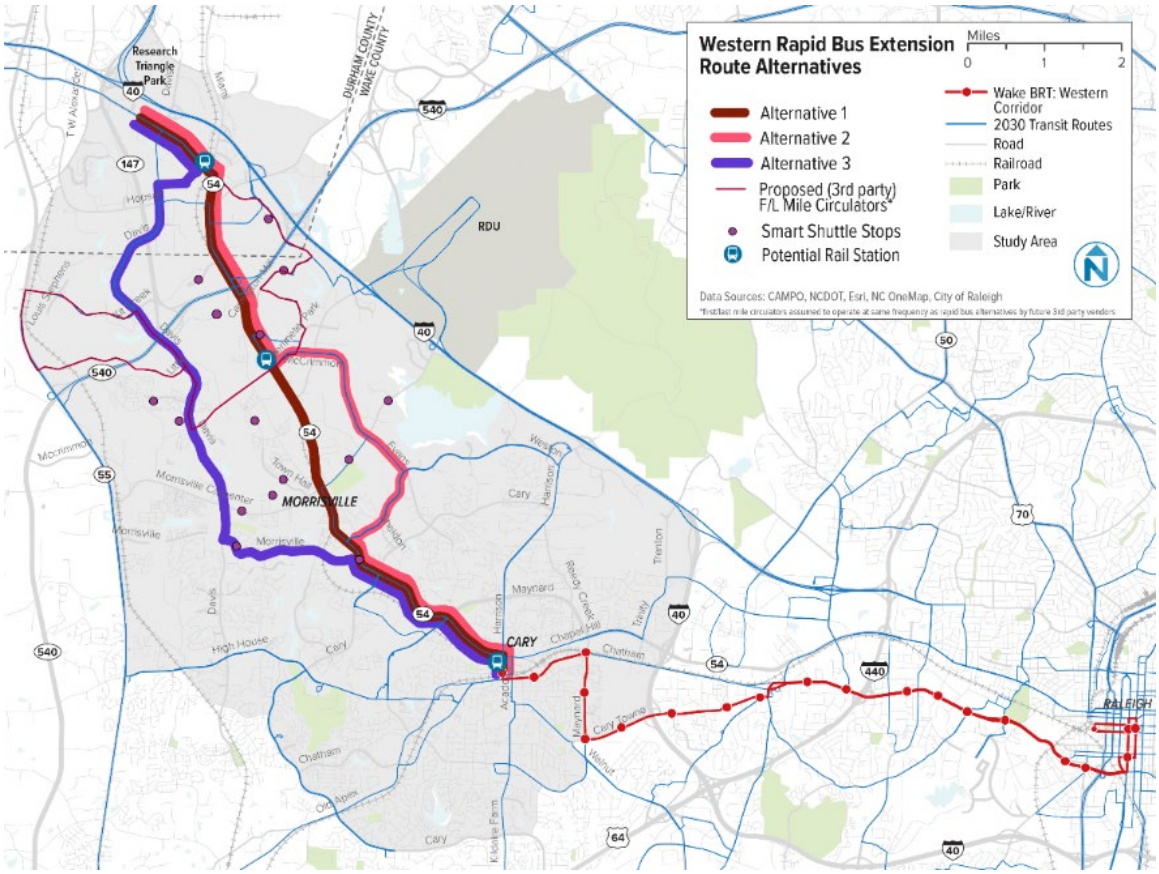
Western Extension

Western Alternatives Alignments

Phase 1 Screening identified three alternatives that could support rapid bus service from Cary to RTP (Figure 8):

- Alternative 1: Cary to RTP via Chapel Hill Road/NC 54
- Alternative 2: Cary to RTP via Chapel Hill Road and Evans Road
- Alternative 3: Cary to RTP via Chapel Hill Road, Morrisville Parkway, and Davis Drive

Figure 8 Western Rapid Bus Extension Route Alternatives



Western Station Area Improvements

The western extension would have approximately 10 to 15 stations, selected based on the presence of activity centers and development nodes, signalized intersections, and accessible pedestrian networks. The design of the stations would be based off Wake BRT: New Bern's peripheral station types, including components such as:

- 24 ft. branded shelters

- Platforms able to accommodate 40-ft or 60-ft buses
- Real-time information
- Lighting and wayfinding
- Fare payment and ticket vending
- Sidewalk connectivity and pedestrian crossing protection

Western Transit Priority Treatments

Transit priority treatments helping rapid bus services operate in a fast and reliable manner assumed transit signal priority (TSP), transit queue jump and bypass lanes, as well as spaces for transit only operations.

- TSP gives buses priority at intersections through adapting signal timings and would be implemented at all signalized intersections within the extension.
- Queue jump or bypass lanes are designated spaces that allow buses to proceed through a signalized intersection ahead of general traffic. TSP technology is also instrumental in initializing the bus-only phase to allow for early procession. These were assumed at signalized intersections where existing or planned roadway improvements support their deployment.
- No dedicated bus lanes were proposed along Western Extension alternatives. In the future, there might be opportunities to explore bus-only lanes or other transitways along the western corridor.

Refer to the *CAMPO Rapid Bus Operating Plan, Feasibility, and Operations Analysis (April 2023)* for further information.

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Western Operating Profile

The rapid bus extension is proposed for revenue service between 2030 and 2040, alongside an updated local bus network and commuter rail. Weekday rapid bus service is proposed to operate from 5AM to midnight, matching that of Wake BRT: Western Corridor. The service would run every 20 minutes at peak and 40 minutes off peak.

If selected as the preferred alternative, Alternative 2 would replace the existing GoTriangle Route 310 service, while Alternatives 1 and 3 would operate as new services.

To remain compatible with maintenance and storage facility (MSF) requirements associated with Wake BRT and GoRaleigh preliminary engineering designs and specifications, rapid bus extensions assume deployment of 40-foot, CNG-fueled buses.

While the detailed evaluation compared the alternatives assuming independent utility (operating from Cary to RTP), the project team's ridership modeling also analyzed the service as a one-seat ride into Raleigh. That analysis assumed compatible vehicles to serve limited stops at major connection points and activity centers along the core BRT segment.

Two on-demand mobility services (RTP Connect and the Morrisville Smart Shuttle Service) currently operate within the Western Extension study area. and are assumed to remain in operation through the 2050 horizon year. Two (2) additional circulators were proposed by this study to rapid bus alternatives with activity centers at the Hub, Metro Triangle, Perimeter Park, and Western RTP (Cisco and Apple campuses). Both circulators follow a fixed alignment with one terminus anchored at the proposed Morrisville CRT station and would operate at 20-minute headways all day matching the span of rapid bus service.

Refer to the *CAMPO Rapid Bus Operating Plan, Feasibility, and Operations Analysis (April 2023)* for further information. This study assumed the development and operating costs of the proposed 3rd party circulator service are the responsibility of local, and potentially benefiting, employers and stakeholders. Circulator capital and recurring operating and maintenance (O&M) costs were not considered in the estimated costs of rapid bus alternatives.

4 DETAILED EVALUATION

OVERVIEW

This section describes the data inputs, analysis and scoring/rating approach, and evaluation results for detailed evaluation criteria. The detailed evaluation of alternatives included both quantitative and qualitative metrics that were analyzed or assessed to compare potential benefits, impacts, and performance differences among rapid bus alternatives.

Performance within each criterion was rated on a scale of 1 to 5 (5 being the highest) and thresholds were established using natural breakpoints in analysis results and/or reasonable comparative performance differences in operations or user experience. Initial evaluation results were shared with stakeholders for comment and revised for final recommendation of preferred alternatives.

Refer to Appendices A1 through A10 for detailed performance analysis results and rating considerations. Additional supporting assumptions, methodologies, and information may be found in the CAMPO Rapid Bus: *Operating Plan, Feasibility, and Operations Analysis Report; Capital Cost Estimate Memo*, and *Travel Demand Modeling Memo*.

> **Notes:** The Southern Extension featured a common trunkline along the primary alignment of US 70 / US 70 Business between approximately Timber Dr and NC 42. For comparative evaluation of Alternatives G1 with G2 and C1 with C2, the characteristics and elements along only the alternative segments were considered in the performance ratings.
>
> Since C2 is a further extension of C1, the C2 alternative evaluation also considered whether the extension provided an incremental benefit / impact / or no effect to the proposed rapid bus service.
>
> Datapoints were also averaged along the primary alignment for use as a comparative baseline.

EVALUATION RESULTS

Employment & Population Density

Employment and population density adjacent to each alternative alignment was analyzed to determine how to maximize connections to the most people and jobs along the alternative roadways. The 2045 population and employment density estimates from the U.S. Census Bureau were analyzed spatially based on ¾ - mile walkshed from the proposed Rapid Bus stations along each alternative alignment.

Southern Extension

Table 1 shows the 2045 population and employment densities for the southern rapid bus Extension where alternative G2 was found to serve the greatest number jobs and people out of all the southern alternative alignments. Many of the existing residential and job concentrations of Clayton and the ECIA are narrowly outside of the ¾ - mile walkshed used in this evaluation. Proposed and aspirational development plans in the Clayton

area were not included within the adopted horizon year 2045 land use data available for this analysis.

Table 1 Southern Extension Population and Employment Density Ratings

Alternative	2045 pop/acre Rating	2045 job/acre Rating	Avg Rating
C1 – NC 42	1	1	1
C2 – Powhatan Rd	1	1	1
G1 – Fayetteville Rd	3	3	3
G2 – Garner Station Blvd	5	5	5

Western Extension

Table 2 shows the 2045 population and employment densities for the western rapid bus Extension. The Chapel Hill Road alignment would serve the greatest number of jobs along the Extension. Many neighborhood nodes and shopping centers are located along Chapel Hill Road including Park West Village, Walmart, Wake Technical Community College. The Evans Road alignment would serve the greatest number of people along the western Extension. The Evans Road alignment would reach many medium- to high-residential neighborhoods and activity centers.

Table 2 Western Extension Population and Employment Density 2045

Alternative	2045 pop/acre Rating	2045 job/acre Rating	Avg Rating
Alt 1 – Chapel Hill Road	3	5	4
Alt 2 – Evans Road	2	5	3.5
Alt 3 – Davis Drive	3	3	3

Key Activity Centers

The density of key activity centers adjacent to each alternative alignment were analyzed to determine how to maximize connections to local or regional destinations as well as daily trip generators (e.g., social services, grocery shopping, healthcare). This criterion was analyzed using the number of key activity centers within ¾- mile of the proposed Rapid Bus stations along each alignment. Key activity centers were identified by the number of employees, as well as stakeholder and CAMPO input.[1] These key activity

[1] Major employers were determined by the number of employees (>1000 employees for the Western corridor, >250 employees for the Southern corridor)

centers included major employers, grocery stores/regional retail centers, special event centers, higher education institutions, and medical and social services.

Southern Extension

Additional employment centers of the ECIA (C2) and retail shopping centers along Garner Station Blvd (G2) contributed to their higher performance in the southern extension. The primary alignment of US 70 / US 70 Business serves the majority of the activity centers and major employers within the extension.

Table 3 Southern Extension Key Activity Centers

Alternative	Rating
C1 – NC 42	1
C2 – Powhatan Rd	2
G1 – Fayetteville Rd	1
G2 – Garner Station Blvd	3

Western Extension

Alternative 2 would serve the greatest number activity centers out of all the alignments, but due to its greater length and commonality with Alternative 1 the relative densities of activity centers were similar. Alternative 3 scored lower due to longer segments of low-density residential and commercial development.

Table 4 Western Extension Key Activity Centers

Alternative	Rating
Alt 1 – Chapel Hill Road	4
Alt 2 – Evans Road	4
Alt 3 – Davis Drive	3

High Transit Use Areas

This modified density analysis approximates the transit demand among communities via an adjusted population density, or the population density weighted by the adopted regional transit propensity factor (TPF). The propensity factor utilizes socioeconomic indicators (e.g. - low-income and zero car households) to identify communities with potentially higher likelihood of transit use for travel to and from daily activities.

The 2045 population density estimates from the U.S. Census Bureau were analyzed spatially based on ¾ - mile walkshed from the proposed Rapid Bus stations along each alternative alignment.

Southern Extension

The C1, C2, and G1 termini are located in highly commercial and industrial locations, with low numbers of residents. The moderately dense, mixed commercial and residential land uses around Garner Station Blvd give G2 the strongest rating.

Table 5 Southern Extension Adjusted Population Density

Alternative	Rating
C1 – NC 42	1
C2 – Powhatan Rd	1
G1 – Fayetteville Rd	1
G2 – Garner Station Blvd	3

Western Extension

With several shared roadway segments and a parallel distance of no more than 2.5 miles between them, the demographic indicators of residents along these alternative alignments were very similar. The greater population of residents along the Alternative 1 and 3 alignments contributed strongly to their higher performance rating.

Table 6 Western Extension Adjusted Population Density

Alternative	Rating
Alt 1 – Chapel Hill Road	5
Alt 2 – Evans Road	3
Alt 3 – Davis Drive	5

Multimodal Connections

Existing and planned multimodal connections were identified in proximity to all alternative alignments. These multimodal connections were based on the number of regional (transit center, regional rail, park and ride, etc.) and local transit (fixed routes, shuttles, on-demand mobility service, etc.) connections that intersect with at least one rapid bus stop on the route, excluding at transit centers. Connectivity also considered the density of sidewalks and active transportation pathways (trails, bike lanes, etc.) within of ¾- mile of proposed Rapid Bus stop locations.

Multimodal, active transportation, and microtransit network service assumptions included those from the NCDOT State Transportation Improvement Program (STIP/TIP), and CAMPO 2045 Metropolitan Transportation Plan (MTP), and CAMPO sidewalks layer from the Wake Bus Plan.

Southern Extension

Table 7 shows the southern Extension multimodal connections for all alternative alignments. All the southern alternative alignments share the US 70 corridor as well as

connect to the same local and transit network services. The lack of substantial multimodal investment in the C2 station area did not provide any differentiation.

Table 7 Southern Extension Transit and Active Transportation Connectivity

Alternative	Regional Transit Rating	Local Transit Rating	Sidewalk Rating	MM Pathway Rating	Avg Rating
C1 – NC 42	3	3	1	3	**2.5**
C2 – Powhatan Rd	3	3	1	3	**2.5**
G1 – Fayetteville Rd	3	3	1	3	**2.5**
G2 – Garner Station Blvd	3	3.5	1	3	**2.6**

Western Extension

While the residential area of Morrisville along Davis Drive has less existing and planned fixed route transit service, the communities feature strong investment in their multimodal network, including connections to the Crabtree Creek Greenway, contributing to its higher rating.

Table 8 Western Extension Transit and Active Transportation Connectivity

Alternative	Regional Transit Rating	Local Transit Rating	Sidewalk Rating	MM Pathway Rating	Avg Rating
Alt 1 – Chapel Hill Road	3	4	3	4	**3.5**
Alt 2 – Evans Road	3	4	3	5	**3.75**
Alt 3 – Davis Drive	2	4	5	5	**4**

Roadway and Land Use Improvements

Planned and programmed roadway and land use improvements were assessed to determine the number of local or statewide projects that are most supportive of Rapid Bus operations. The potential benefits and/or impacts of each project were evaluated based on the known scope of infrastructure improvements and resulting operational changes to pedestrian safety and connectivity, bus travel times and speed, as well as relative implementation timeline and scale of impact/implementation on potential rapid bus service. Each of these factors was ranked on a H/M/L scale and converted to a number scale 1-low, 3-medium, 5-high for aggregate rating.

The projects used to analyze these criteria were derived from NCDOT State Transportation Improvement Program (STIP/TIP), CAMPO 2045 Metropolitan Transportation Plan (MTP), and knowledge from local officials (e.g., Town of Cary). Although many of the planned roadway widening projects could support efficient

operations, they may also negatively impact local pedestrian access to the service by contributing to a hostile crossing environment. This study recommends incorporation of transit priority, additional pedestrian and bike infrastructure considerations within the scope of planned widening and roadway improvement projects aligning with the recommended alternatives.

Southern Extension

There are 14 planned/future projects that may affect the Clayton alternatives C1 and C2 (including the primary alignment of US 70). There are 13 planned projects that may affect the Garner alternative alignments. These projects include roadway widening improvements and grade separations at five intersections along that could pose challenges to rapid bus implementation.

Table 9 Southern Extension Transit Supportive Potential of Planned Capital Projects

Alternative	Avg Relevant Project Rating
C1 – NC 42	4.5
C2 – Powhatan Rd	4.5
G1 – Fayetteville Rd	2.5
G2 – Garner Station Blvd	4.5

Western Extension

There are 14 planned projects that may affect the Alternatives 1 and 2. Roadway widening and grade separation projects on Chapel Hill Rd may improve travel times for transit and general roadway users, but these projects may cause increased travel speeds and vehicle volumes along the roadway, specifically between Aviation Pkwy and NC54/Miami Blvd. Alternatives 2 and 3 also benefit from the widening of Chapel Hill Rd, but Evans Rd is also proposed for widening in sections, elevating it to the highest rating among western alternatives. There are 10 planned projects that may affect Alternative 3, including projects planned on Morrisville Carpenter Road and McCrimmon Parkway.

Table 10 Western Extension Transit Supportive Potential of Planned Capital Projects

Alternative	Avg Relevant Project Rating
Alt 1 – Chapel Hill Road	1.9
Alt 2 – Evans Road	2.4
Alt 3 – Davis Drive	1.6

Transit Priority Opportunities

Transit priority treatments help vehicles maintain speeds and stay on time through congested areas. Utilizing field reviews and visual inspection of the extensions as well

as the results from the detailed evaluation of transit supportive nature of planned/future roadway and land use improvements, this criterion compared the quantity of potential transit priority treatments (TSP, queue jump/bypass lanes, and bus lanes) assumed for each alternative alignment.

Suitability for transit priority treatments considered the planned/future infrastructure and operational conditions of alternative roadways, including lane configurations, traffic signalization, and other network modifications as they align with Wake BRT and best practice BRT design practices and principles.

Southern Extension

TSP installation was assumed at all signalized intersections and existing lane geometry within segments of each alignment are opportunistic for multiple transit queue jump deployments. The proposed widening of US 70 Business between Greenfield Pkwy and NC 42 would also support implementation of BOSS, allowing rapid buses to drive on the shoulder at low speeds during congested conditions and improve schedule reliability. The short length of Alternatives G1 and G2 as well as their proximity to the US 70 / US 401 interchange eliminate or minimize the potential for additional transit priority infrastructure investments.

Table 11 Southern Extension Transit Priority Infrastructure Opportunities

Alternative	Rating
C1 – NC 42	3
C2 – Powhatan Rd	3
G1 – Fayetteville Rd	1
G2 – Garner Station Blvd	1

Western Extension

Assessment of the planned/future conditions did not yield recommendations for any dedicated bus lane segments for alternative alignments. However, TSP installation was assumed at all signalized intersections and existing lane geometry within segments of each alignment are opportunistic for multiple transit queue jump deployments. Alternative 1 has the highest percentage of queue jump opportunities per signalized intersection (18 at 23 intersections). Alternative 2 was found to have the most opportunities overall (19 at 29 intersections). Alternative 3 identified 16 potential queue jumps at 29 total intersections. Additional analysis and conceptual design of potential queue jump locations is required to validate the opportunities identified.

Table 12 Western Extension Transit Priority Infrastructure Opportunities

Alternative	Rating
Alt 1 – Chapel Hill Road	3
Alt 2 – Evans Road	3
Alt 3 – Davis Drive	3

Traffic Operations

The assessment of critical traffic operations and other conditions of the built environment (infrastructure) that may potentially impacts the placement of proposed rapid bus stations, or present barriers/challenges to deployment of transit speed and reliability improvements. The analysis utilized the findings from field reviews and visual inspection of the extensions as well as the results from the detailed evaluation of transit supportive nature of planned/future roadway and land use improvements.

The quantity and significance of potential issues presenting barriers to implementation or operations were rated on a H/M/L scale and converted to a number scale 5-low impact, 3-medium impact, 1-high impact for aggregate rating.

Southern Extension

There were no critical barriers infrastructure barriers or challenges to rapid bus service identified in the alternative C1 or C2 in Clayton. Although buses must cross NCRR to enter the proposed park and ride NC 42, the scheduled frequency of buses and rail traffic at the intersection presents low potential for service impacts. US 70 / US 70 Business corridor traffic congestion and infrastructure improvements would impact alternatives equally.

The US 70 / US 401 interchange significantly limits the ability for any transit priority investment for connectivity to either terminal station location. The routing of Alternative G2 has better direct connectivity to the newly constructed extension of S Wilmington south of Chapanoke Road to a planned tie-in at Garner Station Boulevard as part of the Southern BRT Corridor project.

Table 13 Southern Extension Traffic Operations and Rapid Bus Compatibility

Alternative	Total Score
C1 – NC 42	5
C2 – Powhatan Rd	5
G1 – Fayetteville Rd	2
G2 – Garner Station Blvd	3

Western Extension

Alternative 2 rated highest due to the additional planned widening and roadway improvements on Evans Rd/McCrimmon Pkwy, as well as avoiding approximately 1 mile of critically constrained 1-lane segments of NC 54. Despite having the extension's widest ROW along Davis Dr, the continued expansion of key intersections at proposed station locations to accommodate lane capacity may limit the available ROW outside of the curb for installation of station platforms and transit supportive pedestrian improvements. The proposed routing through Merrion Ave and Faulkner St to the site of the future RTC travels through a highly residential, slow-speed area. Alternative 1 was rated lowest, as several exclusive segments of Chapel Hill Rd / NC 42 narrow to 1-lane and approximately 5 miles of the overall alignment is paralleled closely by NCRR.

Although no dedicated bus lanes are proposed, planned widening along Chapel Hill Rd is a critical piece of enabling infrastructure supporting the reliability of rapid bus for all three alternatives.

Table 14 Western Extension Traffic Operations and Rapid Bus Compatibility

Alternative	Total Score
Alt 1 – Chapel Hill Road	1
Alt 2 – Evans Road	3
Alt 3 – Davis Drive	2

Ridership Potential

Transit travel forecasts were developed for the Rapid Bus extensions of the Western and Southern Bus Rapid Transit (BRT) Corridors in Wake County. The forecasts were developed using Federal Transit Administration's (FTA) Simplified Trips-On-Project Software (STOPS) Version 2.51 (distributed August 2022). The primary analysis tool utilized for the CAMPO Rapid Bus Extension projects was the Triangle Commuter Railway STOPS model v2.51(TCR-STOPS). This implementation of STOPS was designed and calibrated to evaluate the commuter rail and encompasses the entire Triangle region.

The demographic and socio-economic (SE) data used in this forecast is based on the Triangle Regional Model (TRM) G2 adopted forecasts utilizing TAZ-level estimates for population and employment for 2020 and 2050.

Southern Extension

For the purposes of forecasting the range of ridership within the extension and given the ridership differences were believed to be minimal, the various (4) terminal routing combinations were not analyzed individually. Instead, ridership forecasts were used to better understand the impacts between A forced transfer at Garner station (2,350 average weekday riders) and a one-seat ride alternative from Clayton (4,500 average

weekday riders), thus providing a high and low range for the Southern Rapid Bus extension for:

- The shortest end-to-end alignments (G2 – Garner Station Blvd to C1 – NC 42); and
- The longest potential end-to-end alignments (G1- Fayetteville Rd to C2 – Powhatan Rd)

Alternative C2 received a slightly higher rating than C1 due to the additional ridership gained through extending rapid bus service to the ECIA. Similarly, Alternative G2 was rated slightly higher than G1 due to the potential for travel time savings along Mechanical Blvd / Garner Station Blvd.

Table 15 Southern Extension Ridership Potential

Alignment	Rating
C1 – NC 42	3
C2 – Powhatan Rd	3.5
G1 – Fayetteville Rd	3
G2 – Garner Station Blvd	3.5

Western Extension

The Chapel Hill alignment produces the most boardings within the extension (1,050 average weekday riders) compared with 750 and 600 for Alternatives 2 and 3, respectively. Continuing service to downtown Raleigh as a 1-seat ride more than doubled the projected weekday ridership on the rapid bus to approximately 2,200.

Also noted in the *CAMPO Rapid Bus Extension Ridership Estimation memorandum*, the new third-party circulators assumed by this analysis were valuable contributors to transit network performance in western extension, carrying between 60% to +100% of the daily trips as rapid bus service.

Table 16 Western Extension Ridership Potential

Alternative	Rating
Alt 1 – Chapel Hill Road	1.5
Alt 2 – Evans Road	1
Alt 3 – Davis Drive	1

Cost Effectiveness

Results of ridership forecasts were combined with the findings of capital and recuring operating and maintenance (O&M) cost estimating efforts for rapid bus alternatives to express cost effectiveness.

The capital "cost per rider" effectiveness calculation considers annualized capital cost of an alternative, divided by the projected annual riders. Conceptual capital cost estimates were developed based on estimates produced for the New Bern BRT Corridor 90% design and station architectural plans. The total capital cost of infrastructure and vehicles was then converted to an annualized cost based on the typical useful life (years) of the component – guideway, stations, systems, vehicles, etc.

The O&M "cost per rider" effectiveness calculation considers annual O&M cost of an alternative, divided by the projected annual riders. O&M costs were estimated based on the average daily operating statistics of rapid bus corridors. Daily operating statistics were calculated by determining the number of vehicles required to achieve the desired service frequencies during peak and off-peak periods. The number of buses operating in each period is multiplied by the span of the period (number of hours per day) to calculate the total revenue hours for a given day. The total annual revenue hours calculated for each alternative were applied to current unit costs for both GoRaleigh and GoTriangle, providing a range of potential costs.

Southern Extension

The similar length of Alternatives G1 and G2 did not lead to a differentiation in capital or O&M cost for deployment of rapid bus service in the Southern Extension. The C2 extension to Powhatan Rd slightly increased the capital cost to construct an additional station area and affected signal improvements, but the additional distance did not conclusively justify the need for additional fleet vehicles to maintain proposed frequencies.

The Southern Extension Alternatives (over 600,000 annual boardings) were rated higher than Western Extension Alternatives (between 170,000 to 270,000 annual boardings) overall due to the higher projected ridership.

The same annual O&M cost of $1.8M to $2.4M (dependent on GoRaleigh or GoTriangle operation) was estimated for all Alternatives. Capital construction costs of $32M to $35M convert to annualized costs of approximately $10M to $11M.

Table 17 Southern Extension Cost Effectiveness

Alternative	Annualized Capital Cost per Boarding	Operating Cost per Boarding	Average Rating
C1 – NC 42	4	5	4.5
C2 – Powhatan Rd	4.5	5	4.75
G1 – Fayetteville Rd	4	5	4.5
G2 – Garner Station Blvd	4.5	5	4.75

Western Extension

The similar length and number of stations between Alternatives did not lead to a differentiation in capital or O&M cost for deployment of rapid bus service in the Western

Extension. Although the overall lower projected ridership in Western Extension (between 170,000 to 270,000 annual boardings) limited the cost effectiveness potential of alternatives, it was still the driving factor elevating Alternative 1 to the top rating.

The same annual O&M cost of $1.8M to $2.4M (dependent on GoRaleigh or GoTriangle operation) was estimated for all Alternatives. Capital construction costs of $32M to $36M convert to annualized costs of approximately $10.5M to $11.5M.

Table 18 Western Extension Cost Effectiveness

Alternative	Annualized Capital Cost per Boarding	Operating Cost per Boarding	Average Rating
Alt 1 – Chapel Hill Road	3	4	3.5
Alt 2 – Evans Road	1	3	2
Alt 3 – Davis Drive	1	3	2

Transit Travel Time

Travel times were inputs for ridership modeling as well as calculation of service statistics were used in estimating the annual operating and maintenance costs of providing rapid bus service. Several assumptions are included in the estimated travel times. These include conditions while vehicles are in motion, assumptions made about the time waiting for passenger movements at stations, and assumptions made about future travel conditions.

The Transit travel time evaluation consisted of a comparison of average transit travel speed during peak vs. off-peak periods to assess reliability. The potential travel time savings afforded by the transit speed and reliability improvements recommended for each alternative were then estimated using industry standards. Potential time savings were compared to the baseline transit travel time to identify potential benefits to alignments that are likely to experience speed and travel time variability.

Refer to the CAMPO Rapid Bus: *Operating Plan, Feasibility, and Operations Analysis Report* for further information.

Southern Extension

End-to-end travel times for the Garner (G1, G2) to NC 42 segment of the corridor ranged from approximately 31 minutes in off peak to 43 minutes in the peak periods. The variation between the peak and off-peak travel times and speeds was lower on the C2 alternative than baseline trips ending at NC 42 (C1), suggesting that trips are more reliable in this segment and less investment in transit priority infrastructure is needed. However, the additional 3.1 miles to Powhatan Rd added approximately 4 additional minutes of travel time in the 1-way direction, resulting in a lower rating. G2 is the higher rated alternative in Garner due to the out of direction travel and turning movements required for G1.

Table 19 Southern Extension Transit Travel Times

Alternative	Rating
C1 – NC 42	3
C2 – Powhatan Rd	1
G1 – Fayetteville Rd	1
G2 – Garner Station Blvd	3

Western Extension

End-to-end travel times for alignment alternatives ranged from approximately 28 minutes (Alt1) to 34 minutes (Alt 3) in peak periods, and 23 minutes to 29 minutes in the off-peak periods. The Evans Rd alternative projected the highest average travel speed (22.7 mph) and showed the lowest variation between the peak and off-peak travel times. This suggested the corridor was consistently faster trip than other alternatives.

Table 20 Western Extension Transit Travel Times

Alternative	Rating
Alt 1 – Chapel Hill Road	1
Alt 2 – Evans Road	3
Alt 3 – Davis Drive	1

5 SUMMARY

For the purpose of this evaluation of alternatives, rapid bus service assumed independent utility, operating as a separate service from core Wake BRT between Raleigh, Cary, and Garner. Rapid bus passengers would be required to transfer to core BRT vehicles at Downtown Cary and Garner Station termini. However, this analysis does not preclude the buses from the Core BRT alignments onto the rapid bus extensions.

The increased ridership potential and riders experience gained by providing a seamless, 1-seat ride from RTP and Clayton to downtown Raleigh suggest the preferred rapid bus service may consider operating as through service to Raleigh. However, additional coordination with GoRaleigh and the Wake BRT Southern and Western Corridor projects is required to determine the appropriate capital and operating strategies to consider when comparing potential benefits, impacts, and tradeoffs of 1-seat ride service.

A detailed concept of operations (ConOps) involving scheduling analyses is recommended to identify and test potential BRT and rapid bus operating strategies, as well as assess station stop-spacing and compatibility with BRT transitway and station platform infrastructure configurations within the core segments in detail.

RECOMMENDATIONS

Southern Extension

Evaluation results support additional study and coordination to determine alignment and routing options in Garner that most appropriately support Core Southern BRT service operations and connectivity. When analyzed for independent utility, Garner Station Blvd (G2) was the top performing candidate due to its more direct routing, better transit travel time reliability, and connectivity / accessibility benefits over the Fayetteville Rd option.

The optional extension to Powhatan is recommended to connect rapid bus service from the NC 42 park and ride to additional major regional employers in the ECIA with minimal cost to build one additional station. The alignment options at Garner station cover a very short segment of the overall route and assume the same level of construction to complete.

Table 21 Southern Extension Phase 2 Evaluation Summary

Alternative	Weekday Ridership	Capital Cost	Annual O&M Cost	Total Score
(G2) Garner Station Blvd to (C1) NC42	2,340	$32 M	$1.8 M to $2.4 M	G2 – 31.4 C1 – 28.5
(G1) Fayetteville Rd to (C2) Powhatan Rd	2,400	$34 M		G1 – 21.5 C2 – 28.3
Powhatan to Downtown Raleigh (1-seat ride)	4,500	$38 M	$3.5 M to $4.5 M	n/a

Final turn-by-turn alignments and service tie-ins at the termini are also important to refine in the case of the Garner Station alternative alignments (G1, G2), where both are found to be viable routing options to connect with the Southern Corridor BRT terminus. There may be potential tradeoffs regarding routing efficiency for continued one-seat ride service to Raleigh along Garner Station Boulevard (G2) due to the out of direction travel and potential traffic queuing issues at the US 70 westbound to US 401 (Fayetteville Road) southbound turn movement (G1).

Western Extension

Alternative 2 is the top performing alternative (from Cary to RTP), due to better long-term redevelopment opportunity and potential for transit speed and reliability investments.

- Alternative 1 is the most direct alignment and connects to slightly higher density land uses but is also significantly constrained by the railroad (NCRR).
- Alternative 3 would introduce high quality transit service to several communities that do not currently have any. But its routing would not serve the proposed Morrisville commuter rail station.
- Planned roadway improvement projects along Chapel Hill Rd and N.C. 54 are more beneficial to Alternative 1 and Alternative 2 than those along Davis and Dr Alternative 3. Estimated differences for both construction and operating costs are minor between the alternatives.

Table 22 Western Extension Phase 2 Evaluation Summary

Alternative	Weekday Ridership	Capital Cost	Annual O&M Cost	Total Score
Alt 1 – Chapel Hill Road	1,050	$26.1 M	$1.8 M to $2.4 M	28.4
Alt 2 – Evans Road	750	$29.2 M		28.7
Alt 3 – Davis Drive	600	$27.6 M		25.6
RTP to Downtown Raleigh (1-seat ride)	2,200	$36 M to $43 M	$3.6 M to $4.8 M	n/a

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APPENDICES

APPENDIX A PHASE 2 CRITERION AND DETAILED ANALYSIS TABLES

APPENDIX B RAPID BUS AA FRAMEWORK AND PHASE 1 SCREENING MEMO